The idea that some physical truth underlies Bode's empirical law seems to persist in these addresses, and we could hope that there lies the germ of Darwin's next attack on the problems of cosmogony. We naturally cannot agree with all the statements made in what are essentially popular addresses, and we signal as one instance of doubtful reasoning the reference to a condensing ring on p. 537. The effect of a mobile central nucleus inside the ring seems to be left out of account.

Among the miscellaneous papers we select first for mention those dealing with mechanical designs, where the collaboration of the author's brother, Horace Darwin, is again suggestive of later developments; the sandthrust and ripple experiments also give evidence of a side of Darwin's nature not suspected from a casual knowledge of his work. It was with something of a start that the writer found in "A Geometrical Puzzle" a note (dated 1877) referring to an old puzzle which has only recently had a return of popularity. The papers on "Marriages between First Cousins and their Effects" form an appendix which is still of considerable interest to the biological statistician. But if we may judge from the preface the paper to which Darwin would ascribe the greatest value himself is the one on "The Mechanical Conditions of a Swarm of Meteorites." The author notes that the paper has received but little notice, and the reason for this does not seem far to seek. The seat of the controversy has moved away from the point to which the investigation was directed, as is indeed clear from Darwin's own addresses referred to above. The assumptions of a spherical distribution do not apply to a spiral nebula—which has become of recent years the chief source of speculative interest. Lastly, we must mention the paper on the Antarctic tides. It is curious to compare Darwin's forecast of a great unsuspected bay in the Antarctic with Harris's forecast of a large piece of undiscovered land in the Arctic Ocean. Both suggestions have been based on tidal observations, supported to some extent by rival theories. Both are open to proof or disproof through subsequent voyages of exploration.

We have left until last the English text of the important article, "Bewegung der Hydrosphäre," in the "Encyklopädie der Mathematischen Wissenschaften." Here again Mr. Hough has collaborated and added a lucid discussion of the dynamical theory of the tides. The practical application of the theory by the harmonic and synthetic methods are fully discussed, though the treatment is somewhat too condensed for the average reader. A useful bibliography and schedule of the symbols in common use is added, and an account of many miscellaneous investigations, such as the Bidston tidal-load experiments. It is perhaps disappointing to gather that we cannot yet with any confidence make any wide generalisations as to the nature of the tide-wave in the open ocean. But in each unsolved problem lies the charm of the unknown, the fascination which lures the born researcher on to investigation after investigation. That George Darwin by right of descent and by natural aptitude is one who must pursue the search in the unknown is amply testified in his collected works. That he has pursued his investigations in the right spirit his own words testify.

"Man is but a microscopic being relative to astronomical space, and he lives on a puny planet circling round a star of inferior rank. Does it not then seem as futile that he can discover the origin and tendency of the universe as to expect a house-fly to instruct us as to the theory of the motions of the planets? And yet, so long as he shall last, he will pursue his search, and will no doubt discover many wonderful things which are still hidden. We may indeed be amazed at all that man has been able to find out, but the immeasurable magnitude of the undiscovered will throughout all time remain to humble his pride. Our children's children will still be gazing and marvelling at the starry heavens, but the riddle will never be read."

THE SCIENCE OF MODERN ARTILLERY.

Modern Artillery in the Field: a Description of the Artillery of the Field Army, and the Principles and Methods of its Employment. By Colonel H. A. Bethell. Pp. ix+393. (London: Macmillan and Co., Ltd., 1911.) Price 7*s.* 6*d.* net.

THIS book is a welcome sign that the country is beginning to wake up to the importance of the study of artillery science, in which we see such superior interest everywhere abroad.

The territorial is very keen to make himself acquainted with the science of his arm; and in the absence of official financial support this treatise of Colonel Bethell will prove useful to make him without practice into the theoretical gunner, contrasted with the regular gunner, practical man without practice.

In opposition with what can be seen on the Continent, here in this country we have no practice ranges for artillery—*Champs de Tir,* so plentiful in France. We shall have to trust to territorial enthusiasm in antagonism to official neglect for providing at private expense the best amateur substitutes possible, which the regular gunner will be glad to utilise on an emergency when once a system is started; he too is starved in practice to an equal extent.

The retired general officer is not forgotten—landowner and on a pension, who at the end of the last century was so decided in his refusal to give any facility to volunteer rifle shooting; but soon was sorry he had been so outspoken, when the bad news came streaming home from South Africa shortly after.

Modern artillery has been revolutionised by the introduction of the quick-fire (Q.-F.) gun, described with useful diagrams by Colonel Bethell; but the name should be changed to Q.-A. (quick-aim).

By allowing the gun a long recoil of three or four feet over the carriage, the reaction can be reduced until the wheels do not jump off the ground; the carriage remains still, so that a slight adjustment only is required for the next shot.

Without this Q.-A. arrangement the Q.-F. principle cannot be utilised; and one of these guns is a match for six of the type we used in South Africa.

The gunner who fires the gun is still called by official misnomer the "layer"; but he does not

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"lay"; he merely keeps the telescopic sight on the mark and fires as fast as the gun can be loaded—twenty times a minute. He is the *pointeur*; other gunners attend to laying of the gun, in giving the elevation to correspond with the range finder, and in setting the fuse, for which a special instrument has at last been introduced; others traverse the gun when required and hand over the ammunition, and all can work in security behind a steel shield. But the man who fires the gun gives his individual attention to "pointing."

Official optimism at the end of the last century had declared our artillery to be perfect—a sure prelude to disaster. We know now that it was fit only for the scrap heap, and would have been knocked out in the first encounter with a European Power; and the German mercenary gunner in Africa was more than a match for our regular artillery.

We must look to France for the most modern development of artillery science, as our military authority is quite content on a back seat.

Parts iii. and iv. have the appearance of being lifted from a French source. The territorial gunner will profit at his leisure by a study of these parts and the useful hand sketches; also in walking over the ground in his neighbourhood with eyes open; his opportunity of actual insight at manœuvres will be small.

The word mobility is always in vogue, with little grasp of its meaning.

After a war the cry is always for a more powerful gun; and our eighteen-pounder weighs 24 cwt. on a pair of wheels. This is too much for the road and the team, and is putting the cart before the horse according to the proverb modified. A field gun must be able to leave the road and cross a ploughed field, so that the old definition of the Act of Parliament of Henry VII. still holds good, of a ton as a cartload, in fixing the standard weight to be carried on a pair of wheels.

But in a long peace, when smart evolutions are considered of more importance than gunnery, and mobility comes to mean a gallop with no reality between the team, the weight decreases to an opposite extreme.

The horse scarcity is becoming acute with the advance of the motor-car. Territorial gunners will have to learn their drill indoors with blocks of wood and toy soldiers, like naval officers playing a war game on the gun-room table; and this book will provide plenty of ideas for abstract tactical problems.

The artillery tactics of the flying machine come in for discussion. These tactics have been worked out long ago by the French, and the dirigible balloon was directed to take up a place of safety hovering vertically overhead, as then the enemy would not dare to fire with the prospect of the shot descending on his own head or his friends'.

We prefer to think of the flying machine as a dragon-fly, in the German name, harmless and lovely for our delectation. But no public funds would be available if it could not be shown that the flying man could be utilised for human destruction, employed as "the light militia of the lower sky."

G. Greenhill.

INSULATING MATERIALS AND ARMATURE WINDINGS.

(1) *Les Substances Isolantes et les Méthodes d'Isolement utilisées dans l'Industrie Électrique.* By Jean Escard. Pp. xix+313. (Paris: Gauthier-Villars, 1911.) Price 10 francs.

(2) *Les Enroulements Industriels des Machines à Courant continu et à Courants alternatifs: Théorie et Pratique.* By E. Maree. With a preface by Paul Janet. Pp. vii+240. (Paris: Gauthier-Villars, 1911.) Price 9 francs.

(1) A TREATISE on insulating materials conceived in a scientific spirit would certainly be welcome to many electrical engineers, and on reading the author's preface to his attempt to write such a treatise one concludes he has approached his subject from this point of view. He tells us that his work is not intended to be a mere enumeration of the various insulating materials available, but a critical investigation, such as will help the practical engineer to make in each case the best selection possible. Good as the author's intentions were, his performance falls short of them.

There is, to begin with, a good deal of matter in his book which has nothing whatever to do with insulating materials. The first forty pages are devoted to a discussion of metallic and liquid conductors, and here we find merely a repetition of statements and figures which will be found in any text-book on physics. This is padding; so is the picture of a drilling machine, that of a shop in which tissue paper is pasted on to transformer plates, and so are the illustrations of various wooden and ferro-concrete telegraph poles. To drag in the coherer used in wireless telegraphy is also padding, pure and simple. That the insulating properties of concrete are discussed is quite right, but it is misleading to draw any conclusions from it in respect of the insulation of dynamos. Yet on p. 128 we are told that small machines are generally placed on timber, and are thus sufficiently insulated from earth. Large machines must be put on a concrete foundation, and although this is not an absolute insulator, it is a sufficiently poor conductor to prevent any considerable escape of electricity to earth. But precautions are necessary; the foundation must be kept dry, and to this end one must avoid the neighbourhood of steam and water pipes, and one must dry the air in the engine-house by ventilating fans. How a steam dynamo is to be driven without steam and water pipes coming near it the author does not explain.

As regards special insulating compositions, there is little more than enumeration accompanied by some general remarks, such as one might find in a trade list. In some cases the composition is given in detail, but no definite electrical data. We find such trade names as "Radoonite," "Terracite," "Refragor," "Megotalc," "Micacementite." The last-mentioned material is said to withstand vibration, and we are told that certain traction motors which were not insulated with it broke down after a run of 20,000 km., whereas after this material was used

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